lines, and works preparatory to bringing the new lands under culture.

The interest on the above sum will raise it to 13,400,000*l.*, but one-fourth of this will be granted as a subsidy by government, which will be amply compensated by the comparatively enormous addition to its small territory.

Of the 473,000 acres to be drained, four-fifths, as we have said, are of great value, composed as they are of a bed of more than a metre thick of the most fertile mud deposited for centuries by the Yssel and other rivers of which the Zuyder Zee is the receptacle. Only one-fifth consists of land of less value and of sands which will be useful in constructing the base of the dike, or to establish large reservoirs, indispensable in all drainage work, for the reception of the waters until they can be conveyed to the sea. Deduction being made for the land absorbed by these works, by canals, dikes, roads, &c. &c., there will remain upwards of 400,000 acres suitable for culture, and the selling value of which ought considerably to exceed the expenses of the enterprise. Every one must wish that this bold and really beneficent scheme may be carried out with complete success.

THE BIRDS OF NORTH-EASTERN AFRICA[1]

BARON THEODOR VON HEUGLIN is well known as one of the most active and successful of the travellers and naturalists of Germany—one who may fairly rank with the Wallaces and Bates of our own country—as regards the extent of his researches. No man living has devoted more time and toil to the investigation of the Fauna of North-eastern Africa, and as regards the classes of birds and mammals, no man living has a better acquaintance with them. Twelve years passed on the coasts and islands of the Red Sea, in the marshes and jungles of the White Nile, and in the Highlands of Abyssinia, during which time constant attention was devoted to the observation and collection of animals have given Herr von Heuglin unrivalled opportunities for amassing this knowledge, to which his skill as an artist has contributed additional facilities. Soon after returning from his last journey in 1865, Herr von Heuglin planned a general work on the Ornithology of North-eastern Africa to embrace all the notes and observations collected during his different excursions, together with the information acquired by the study of specimens from these countries already existing in the continental museums. In 1869, the first part of the present work was issued, but its large extent hindered its progress, and the author was called away to join the German Expeditions to Nova Zembla and the extreme north, to which he was attached as naturalist. It was not, therefore, until the close of last year, or, we believe we may say until the beginning of the present year, that the concluding part of the Ornithology of North-eastern Africa was issued from the press. Completed, it now forms four volumes, illustrated by fifty-one coloured plates and a map of the region of which it treats, and is by far the most perfect work on the subject hitherto published. Prior to the completion of the present work Rüppell's Atlas, and other publications were, so far as regards Nubia and Abyssinia, the only works of reference, whilst of the district of the White Nile so fully explored by Von Heuglin, very little was known except from fragmentary notices. In the present extended work the ornithology of the whole of these countries, together with that of Egypt, the Red Sea, and Northern Somali-land, are treated of together. The sum of species of birds is thus raised to a high figure, no less than 948, of which upwards of 200 are entirely confined to North-eastern Africa. European species are likewise numerous in these countries, Northern Africa being, as is well known, the favoured haunt of our summer migrants during the winter season. Upwards of 300 European birds thus come to be included in Herr von Heuglin's list. The plan of our author's work is good, though it seems to be rather adapted for the home student than for the field-naturalist, neither family nor generic characters being included. But we observe with pleasure that specific diagnoses are given in Latin to all except the best known species, which, after the contumely that certain imperfectly educated naturalists have recently thought fit to bestow upon that classical tongue, is worthy of all praise. The references to former authors are also numerous, and, so far as we have been able to test them, more accurate than is too often, unfortunately, the case in works of this kind. But the great feature of the book are the observations on the habits and localities extracted from the note-books of the unwearied author. These are much more numerous, and better put together than in almost any other work on foreign ornithology with which we are acquainted. Errors and omissions there are no doubt, and must be, in a work of this magnitude, as indeed is sufficiently evident by the many pages of additions and corrections annexed to the fourth volume, but Herr von Heuglin has spared no trouble to bring his Ornithology of North-eastern Africa up to date, and his volumes will long remain a standard work of reference upon the birds of these districts, which are now attracting so much attention in civilised Europe. P. L. S.

[1] "Ornithologie Nordost-Afrika's, der Nilquellen und Kusten-Gebiete, des Rothen Meeres und des nordlichen Somal-Landes," von M. Th. von Heuglin. In vier Theilen. (Cassel: Fischer, 1869-1874.)

FERTILISATION OF FLOWERS BY INSECTS[1]

XIII.

Additional Alpine Flowers adapted to Cross-fertilisation by Lepidoptera.

THE same relation which I have shown to exist between *Daphne Mezereum* and *striata*, *Primula officinalis* and *villosa*, *Rhinanthus crista-galli* and *alpinus* (NATURE, vol. xi. p. 110), exists also between *Viola tricolor*[2] and *calcarata*, the former inhabiting the plain and the lower mountainous localities, and being adapted to cross-fertilisation by bees; the latter, on the contrary, inhabiting the higher Alpine regions, and being adapted to fertilisation by butterflies.

Viola calcarata is found in the Strela pass towards Davos (2,300 metres above the sea-level), and in the rocky slopes of Piz Umbrail towards Quarta Cantoniera (2,600-2,700 m.) in such plenty as to appear from some distance like a blue carpet of flowers. In the latter locality, July 15, 1875, I saw these flowers assiduously visited by different butterflies, of which I caught two specimens of *Colias phicomone*, and three *Erebia laprona E.* (manto, W. V.) The modifications of structure by which the flowers of *V. calcarata* (Fig. 82-85) differ from those of *V. tricolor* (Fig. 15-22, NATURE, vol. ix., p. 46), besides their eminent conspicuousness, so frequently found in Alpine flowers, are such as prevent Diptera and probably also Apidæ from sucking the honey, whereas butterflies, for which alone the honey is reserved, cannot suck it without effecting cross-fertilisation. For the spur, which generally is only 3-4 mm. long in *V. tricolor*, exceeds in this species 10 mm. in length, its width being only 1 mm. in the vertical, and scarcely half a millimetre in the horizontal direction; and the stigmatic knob, provided with a labiated appendage, as in the large-flowered form of *V. tricolor*, lies so closely pressed against the under lip, that no proboscis of any butterfly can enter the spur without grazing the stigmatic lip. The pollen-grains, when they fall out of the anthers, collect in the hairs which clothe the furrow of the under lip (*po* Fig. 85), and no proboscis of a butterfly can be inserted into the spur without being smeared with pollen-grains, which, in the flower next

[1] Continued from vol. xiii., p. 212.

[2] See H. Müller, "Die Befruchtung der Blumen durch Insecten" Leipzig, 1873, p. 145, and NATURE, vol. ix. p. 44.

visited, will be partly rubbed off on to the lip of the stigmatic cavity (*l* Fig. 85). All the other contrivances of the flower are nearly the same as in the large-flowered form of *V. tricolor*, described in detail in a previous article (NATURE, vol. ix. p. 47).

It may be worth mentioning that in the lower Alpine localities (for instance, near Valcava, 1,500 m., and near St. Gertrud, Sulden, 1,800 to 1,900 m. above the sea-level) I found a variety of *V. tricolor*, which, as well in the conspicuousness of its flowers as with regard to its fertilisers, is intermediate between the large flowered form of *V. tricolor* (NATURE, vol. ix. p. 46, Fig. 15) and *V. calcarata* (Fig. 82). The flowers of this variety, which is called *alpestris*, are 25-30 mm. long, and 18-22 mm. broad; the three lower petals are yellow near their base, as in our *tricolor* and *calcarata*, marked with black streaks converging towards the entrance of the flower; the two upper petals are very variable in colour, white, or bluish, or yellow, with a large bluish margin. The spur is also

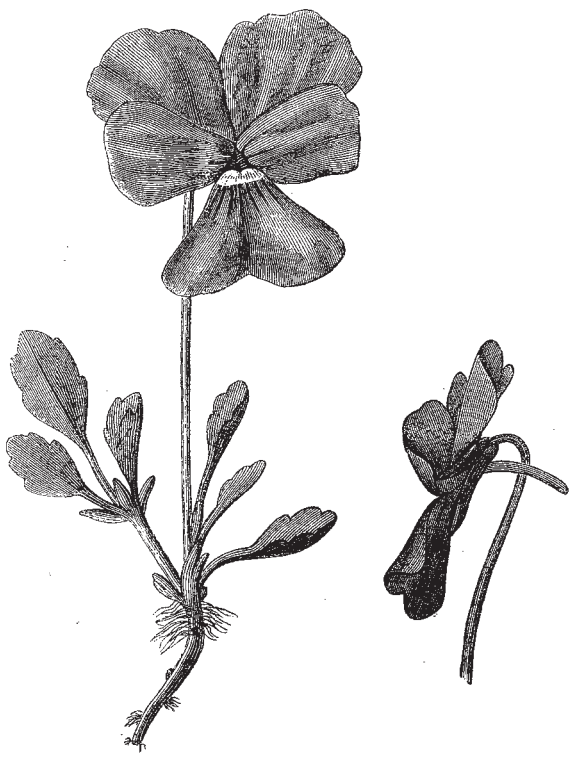


FIG. 82. FIG 83.

FIG. 82-85.—*Viola calcarata*.[1] FIG. 82.—Whole plant, showing a flower in front, natural size.
FIG. 83 —The same flower, laterally viewed, showing the long slender spur.

variable in length, but on an average remarkably longer than in our *V. tricolor*. I found the flowers of this variety frequently visited by butterflies (*Polyommatus virgaureæ*, L., *P. hippothoë*, L., var. *eurybia*, Ochs., ♂, *Lycaena semiargus*, Rott., *Argynnis pales*, *Hesperia serratulæ*, Ramb.), but only once by a humble bee (*Bombus terrestris*, L., ☿, sucking), whilst our *V. tricolor* is generally visited by *Apidæ*, more rarely by butterflies, and *V. calcarata* exclusively by butterflies. Thus *Viola tricolor*, var. *alpestris* shows us one of the steps by which the common form of this species may have been gradually modified into *V. calcarata*.

Another Alpine flower, remarkable from its conspicuousness and adapted to Lepidoptera, is *Lilium bulbiferum* (Fig. 86-88), which I found on stony slopes of the Schanfick valley, near Chur, in the Spoel Valley, near Zernetz, and, somewhat more frequently, in shelving meadows of the valley of Sulden, beneath the Ortler (1,700-1,800 m. above the sea-level). Although in most points of its structure agreeing with *Lilium Martagon*, described in my article X. (NATURE, vol. xii. p. 50), this flower may be of some interest, because it shows by what slight modifications a sphingophilous species may be adapted to diurnal Lepidoptera, or *vice versâ*. The number and arrangement of the parts of the flower and the structure of the nectary (Figs. 87, 88) are, indeed, the same in *L. bulbiferum* as in *L. Martagon*. That, nevertheless, the latter is cross-fertilised by Sphingidæ, the former by diurnal Lepidoptera, is proved by the following differences:—

1. The flowers of *L. Martagon*, being dark reddish brown, and in the daytime but faintly scented, are only slightly attractive to day-fliers, whilst during the evening

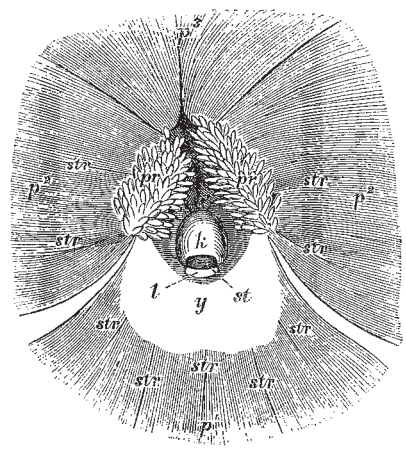


FIG. 84.—Entrance to the flower: seven times natural size.

they emit a very attractive sweet odour. *L. bulbiferum*, on the contrary, by the unusual size of its flowers, with a diameter exceeding 100 mm., and by their colour appearing very splendidly red in the sunshine, is most conspicuous in the daytime, even from a great distance; but being but slightly scented, is incapable of efficaciously attracting night-fliers either by its odour or its colour.

2. The flowers of *L. Martagon* are generally bent downwards, and its sepals and petals reflexed so far as to place the entrances to its nectaries in a nearly horizontal direction, its stamens and pistils projecting downwards, with only their ends slightly bent upwards (Fig. 63, NATURE, vol. xii. p. 50). Thus it affords no landing-place, and offers its honey exclusively to such insects as are capable of inserting a long slender proboscis into the flowers, while they hover in the air by very rapid movements of their wings. *L. bulbiferum*, on the other hand, having its flowers obliquely upright, and offering to their visitors a commodious standing-place on the lowermost petals or sepals, the honey of the lowermost nectaries is accessible to every insect the proboscis of which is long and slender enough to be inserted into the honey-secreting channel.

3. Cross-fertilisation by visiting Sphingidæ is effected in *Lilium Martagon* by the pistil overtopping the anthers, and therefore being first touched by the legs and underside of the visitors, and thus smeared with the pollen of flowers previously visited. In *L. bulbiferum* cross-ferti-

[1] *a* anthers; a^1, upper anther; a^2, insertion of the removed lateral stamen; a^3, lower anther; ap^1, appendage of the upper sepal; *b*, beard, *i.e.*, tuft of hairs; *cb*, the lateral surface of the stigmatic knob; c^1, c^3, orange-coloured appendages of the connectives; f^1, f^3, filaments; *k*, knob of the stigma; *l*, lip, labiate appendage of the stigmatic opening; *n*, nectary, *i.e.*, honey-secreting appendage of the lower filaments; *ov*, ovary; *p*, petals; p^1, lower, p^2, lateral, p^3, upper petal; *po*, pollen-collecting hairs; *pr*, protective hairs (Sprengel's "Saftdecke"); *s*, sepals; s^1, upper sepal (with the appendage ap^1); s^2, lateral sepal; *sp*. the uppermost part of the spur, containing the honey; *st*. stigmatic cavity; *str*, streaks converging towards the entrance of the flower (Sprengel's "Saftmal"); *sty*, style; *y*, yellow part of the lower petal. (The rest of the corolla is blue.)

lisation would be prevented if the sepals and petals were as much reflexed as they are in *L. Martagon*; for butterflies would sit down on them and suck the honey out of the channels at their base, without touching the stigma or anthers. But in this species only the ends of the sepals and petals are spread apart, whilst, as far as the sexual organs extend, the leaves of the perianth diverge but so slightly that a butterfly, when inserting its proboscis into the nectary, can scarcely avoid touching the stigma and anthers; and, the pistil being situated nearest to the

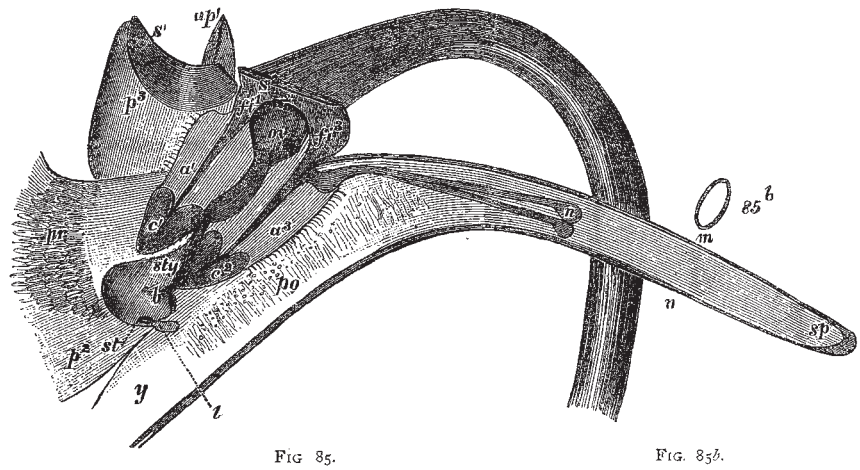


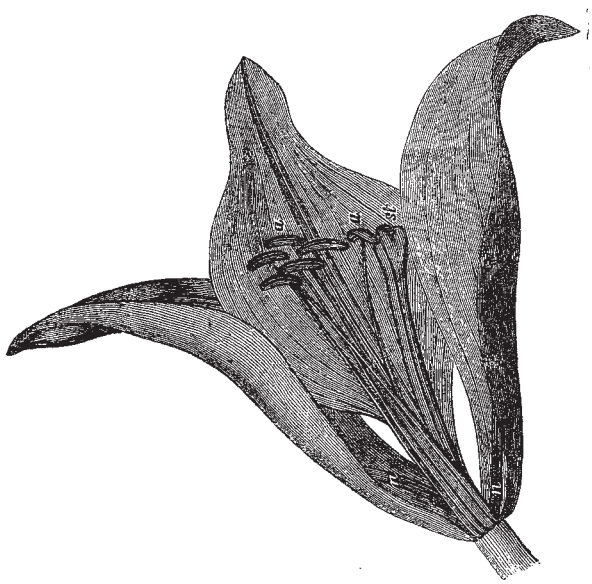
FIG 85. FIG. 85*b*.

FIG. 85.—Lateral view of the flower after the halt of its sepals and petals and one of the two lateral anthers have been removed and the underlip somewhat depressed: seven times natural size. FIG. 85*b*.—Transverse section of the spur, behind the line *m n*, Fig. 85.

lowermost petals and sepals on which the butterflies alight and suck, the stigma here also will be commonly first touched and thus fertilised by pollen-grains of flowers previously visited.

Although, by the contrivances now described *Lilium bulbiferum*, from its very conspicuous flowers, is very likely to be cross-fertilised by butterflies in sunny weather, still in rainy periods many flowers may wither without having received any visit from a butterfly. Hence the possibility of self-fertilisation appears to be indispensable both to *L. bulbiferum* and to *L. Martagon*. In both the anthers and stigma are simultaneously developed to maturity, and are often found in contact with each other; and self-fertilisation may thus be effected in case cross-fertilisation by visiting Lepidoptera is wanting.

4. Direct observation of the visitors proves that *L. Martagon* is really fertilised by Sphingidæ, for instance by *Macroglossa stellatarum*, as observed by myself (see NATURE, vol. xii. p. 50), and by *Sphinx euphorbiæ*, as observed by Federico Delpino;[1] and that *L. bulbiferum* is really fertilised by butterflies, for instance by *Polyommatus virgaureæ*, L., *P. hippothoë*, L., var. *eurybia*, Ochs.,



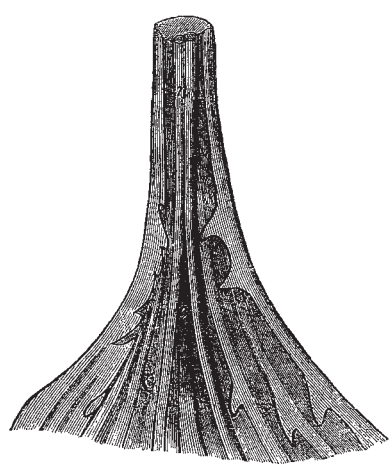


FIG. 86-88.—*Lilium bulbiferum*. FIG. 86.—Lateral view of the flower after the half of the perianth has been removed; natural size. *a*, anthers; *st*, stigma; *n*, nectary.

FIG. 87.—Basal portion of one of the leaves of the perianth. *e*, entrance into the nectary; *n*, nectary: magnified twice.

and *Argynnis aglaia*, L., all of which (July 20, 1875) I found repeatedly in the flowers, not only sucking the honey, but also resting, displaying their wings in the sunshine, and sometimes a male of *Palyommatus virgaureæ*, L., sitting by the side of a female of the same species.

It is a striking fact that all these species of butterflies are of nearly the same splendidly red colour as the flowers they visit. I do not know whether this fondness has been effected by natural selection, agreement of colour

[1] Written to me in a letter of May 1875.

with the flower they sit upon making the butterflies invisible to their pursuers, or if merely the same predilection for a certain colour which has ruled the sexual selection of these butterflies, and by this influenced the colour of their wings, impels them also preferably to visit flowers of their favourite colour; but, from many analogous observations to be published on another occasion, I am strongly inclined to believe that the agreement of colour between the flowers of *L. bulbiferum* and their visitors is not a merely fortuitous one.

Most of the differences between the flowers of *L. Martagon* and *bulbiferum* may be intelligible from the pre-

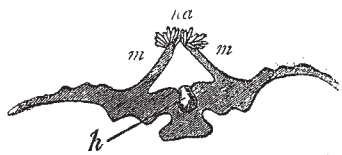


FIG. 88.—Transverse section through the base of one of the leaves of the perianth; seven times natural size. *h*, honey filling up the furrow from which it is secreted; *m*, margins covering the furrow; *ha*, hairs closing the slit between these margins.

ceding explanation;—still the question remains: What intermediate contrivances are imaginable by which the transformation of a sphingophilous species of Lilium into another one adapted to butterflies could be effected? In this respect it is remarkable that the flowers of *L. Martagon* are not always bent downwards, but sometimes have their axis in a horizontal or somewhat upright position, and that such flowers are now and then also fertilised by day-fliers. Thus, July 19, 1874, near Franzenshöh, I saw a specimen of *Zygæna transalpina*, Esp., visiting the flowers of *L. Martagon*, and inserting its proboscis into the honey-secreting channels; and likewise, July 20, 1875, near St. Gertrud, in the valley of Sulden, a specimen of *Polyommatus hippothoë*, var. *eurybia*, Ochs., behaving in the same manner. HERMANN MÜLLER

SCHOLARSHIPS AND EXAMINATIONS FOR NATURAL SCIENCE AT CAMBRIDGE, 1876.

THE following is a list of the Scholarships and Exhibitions for proficiency in Natural Science to be offered at the several Colleges and for Non-Collegiate Students in Cambridge during the present year:—

Trinity College.—One or more Foundation Scholarships of 100*l.* and one Exhibition of 50*l.* The examination for these will commence on April 18. The Scholarships are open to undergraduates of Trinity College, and persons under twenty who are not yet resident members of the University. The Exhibition is open to persons under twenty, who have not yet commenced residence at the University.

St. John's College.—One of the value of 50*l.* per annum. The examination (in Chemistry, Physics, and Physiology, with Geology, Comparative Anatomy, or Botany) will commence on April 22, and will be open to all persons who have not commenced residence at the University, as well as to all who have entered and have not completed one term of residence. No candidate will be examined in more than three of the above subjects. There is a separate examination in Natural Science at the time of the annual College examination at the end of the academical year, in May.; and Exhibitions and Foundation Scholarships will be awarded to students who show an amount of knowledge equivalent to that which in Classics or Mathematics usually gains an Exhibition or Scholarship in the College. In short, Natural Science is on the same footing with Classics and Mathematics, both as regards teaching and rewards.

Christ's College.—One or more in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three and a half years, and for three years longer by those who reside during that period at the College. The examination will be on April 4, and will be open to anyone, whether a member of the College or not—provided his name is not on the boards of any other College in the University—who is not of sufficient standing to be admitted *ad titulum Baccalaurei in Artibus*. The candidates may select their own subjects for examination. There are other Exhibitions which are distributed annually among the most deserving students of the College.

Gonville and Caius College.—One of the value of 60*l.* per annum. The examination will be on April 4, in Chemistry and Physics, and Zoology with Comparative Anatomy and Physiology; it will be open to students who intend to commence residence in October, and are under twenty. Further information may be obtained from the Tutors.—Scholarships of the value of 20*l.* each or more are offered annually for Anatomy and Physiology to members of the College.

There will be an examination on the 4th of April, 1876, in Botany and Comparative Anatomy in its most general sense (including Zootomy and Comparative Physiology), for two *Shuttleworth Scholarships*, each of the value of 60*l.* per annum, and tenable for three years. The candidates must be registered medical students of the University who have kept eight terms, have passed the Additional Examination required for Candidates for Honours, and produce satisfactory testimonials of good conduct. A successful candidate, if not a member of Gonville and Caius College, must become a member of the same. They are tenable with any other Scholarship at the College.

Gentlemen elected to the *Tancred Medical Studentships* are required to enter at this College; these Studentships are five in number, and the annual value of each is 100*l.* Information respecting these may be obtained from B. J. L. Frere, Esq., 28, Lincoln's Inn Fields, London.

Clare College.—One of the value of 60*l.* per annum, tenable for two years at least. The examination (in Chemistry, Chemical Physics, Zoology with Comparative Anatomy and Physiology, Botany with Vegetable Anatomy and Physiology, and Geology) will be on March 28th, and will be open to students intending to begin residence in October.

Downing College.—One or more of the value of 60*l.* per annum. The examination (in Chemistry, Comparative Anatomy and Physiology) will be on, or about, April 25, and will be open to all students not members of the University, as well as to all undergraduates in their first term.

Sidney College.—One of the value of 60*l.* The examination will be on April 4, and will be open to all students who intend to commence residence in October.

Emmanuel College.—One of the value of 70*l.* The examination on April 4, in Botany, Chemistry, Chemical Physics, Geology and Mineralogy, Zoology, Comparative Anatomy and Physiology, will be open to students who have not commenced residence.

Non-Collegiate Students.—An Exhibition each year is given by the Clothworkers Company, value 50*l.* per annum, tenable for three years. Examination about Christmas, open to non-collegiate students who have commenced residence in the October term, and to any who have not commenced residence. Information to be obtained from the Rev. R. B. Somerset, Cambridge.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates than to induce them to present a superficial knowledge of several.

Candidates, especially those who are not members of the University, will, in most instances, be required to show a fair knowledge of Classics and Mathematics, such, for example, as would enable them to pass the previous examination.

There is no restriction on the ground of religious denominations in the case of these or any of the Scholarships or Exhibitions in the Colleges or in the University.

Further information may be obtained from the Tutors of the respective Colleges, and the names, with certificates of character, date of birth, &c., must be sent to the Tutor of the College, in each case, several days before the examination.

Some of the Colleges do not restrict themselves to the number of Scholarships here mentioned, but will give additional Scholarships if candidates of superior merit present themselves; and other Colleges than those here mentioned, though they do not offer Scholarships, are in the habit of rewarding deserving students of Natural Science.

It may be added that Trinity College will give a Fellowship for Natural Science, once, at least, in three years; and that most of the colleges are understood to be willing to award Fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.